PHYSICS

Paper – 1

(THEORY)

Three hours and a quarter

(The first 15 minutes of the examination are for reading the paper only.

Candidates must NOT start writing during this time).

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*Answer **all** questions in Part I. From Part II, answer any four questions from Section A, any three questions from Section B and any two questions from Section C.*

All workings, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.

The intended marks for questions are given in brackets [ ].

A list of useful physical constants is given at the end of the question paper.

PART I (40 marks)

Answer **all** *questions.*

Question 1.

(a) Each question is followed by four possible choices of answers. Choose the correct answer and write it in your answer sheet. **[10]**

(i) Kirchhoff's first law deals with the conservation of

A charge.

B energy.

C momentum.

D angular momentum.

(ii) When light travels from one medium to another the characteristic which does not change is the

A wavelength.

B amplitude.

C frequency.

D velocity.

(iii) In forward bias, the width of depletion layer in a p-n junction

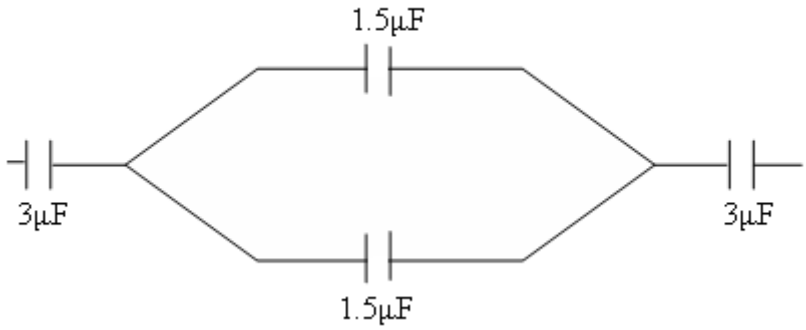
A increases.

B decreases.

C remains unchanged.

D first decreases and then increases.

(iv) What is the equivalent capacitance of the following circuit?



A $3\mu F$

B $2\mu F$

C $1.5\mu F$

D $1\mu F$

(v) The magnetic field lines

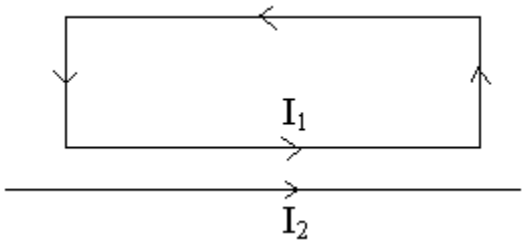
A cannot intersect at all.

B intersect at the neutral point.

C intersect near the north and south poles.

D depend upon the position of the magnet.

(vi) A rectangular loop carrying a current I_1 is placed near a long straight wire as shown in the figure.



If the wire carries a current I_2 and is parallel to one of the sides of the loop, then the loop will

A rotate about the axis parallel to the wire.

B move away from the wire.

C move towards the wire.

D remain stationary.

(vii) A single slit diffraction pattern is obtained using a beam of red light. What will happen if the red light is replaced by blue light?

A Diffraction fringes become narrow and crowded together.

B Diffraction fringes become broad and farther apart.

C There is no change in diffraction pattern.

D Diffraction pattern disappears.

(viii) If c is the velocity of light then momentum of photon of frequency f is

A hf^2/c .

B hf/c .

C f/c .

D hfc^2 .

(ix) The energy of an electron in the first orbit of an atom is -27.2 eV. What will be the energy in the third orbit?

A $3.02eV$

B $1.51eV$

C $-3.02eV$

D $-1.51eV$

(x) The critical mass of a fission reaction is the

A size of the reactor core.

B minimum mass for a chain reaction.

C maximum mass for a chain reaction.

D size of the fuel and the size of the moderator.

(b) Choose the correct word/s given in the brackets and write them in your answer sheets. **[6]**

(i) The ……. of the material of a prism for any two colours may be defined as the ratio of angular dispersion for these two colours to the ……. suffered by the mean light. (chromatic aberration / dispersive power / deviation / dispersion)

(ii) The path difference for maxima is ……. and for minima is …….

($n\lambda$ / $2n\lambda$ / $(2n+1)\frac{\lambda}{2}$ / $(3n+1)\frac{\lambda}{2}$)

(iii) The base of a transistor is always ……. and …….. doped compared to the emitter and collector. (thicker / thinner / lightly / heavily)

(iv) In photoelectric effect, stopping potential depends on ……. of light photoelectric current depends on ……. of light. (frequency / velocity / intensity / amplitude)

(v) Beta rays are same as ……. and gamma rays are same as …….
(anode rays / cathode rays / sound wave / light wave)

(vi) The depolarizer used in a Leclanche cell is ……. while ……. is used in a Daniel cell. (NH_4Cl / MnO_2 / $CuSO_4$ / H_2SO_4)

(c) Match the items of column A with the items in column B. Rewrite the correct pairs in your answer sheet. **[4]**

Column A	**Column B**
(i) Parallel plate capacitor	(a) longitudinal wave
(ii) Bohr	(b) energy to mass
(iii) Binding energy	(c) $f_0 < f_e$
(iv) Pair production	(d) transverse wave
(v) Polarization	(e) $f_0 > f_e$
(vi) Infrared radiation	(f) Δmc^2
(vii) Telescope	(g) $C = \frac{\varepsilon_0 A}{d}$
(viii)Compound microscope	(h) stationary orbit
	(i) heat wave
	(j) $C = 4\pi\varepsilon_0 r$

(d) Write True or False and give reasons for the false statements. **[4]**

(i) In LED, the junction diode is reverse biased.

(ii) Compton shift depends on scattering angle θ of recoil electron.

(iii) Neutral temperature changes with change in temperature of cold junction of the same thermocouple.

(iv) Dielectric substance placed between two plates of a capacitor increases the potential energy of the plates.

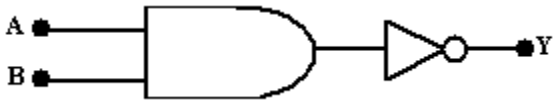
(e) Answer the following questions.

(i) When a current of 2mA flows through a coil, a magnetic flux of 6μWb is produced. What is the self inductance of the coil? **[2]**

(ii) Derive the relation between the energy and the momentum of a photon. **[2]**

(iii) Deduce the magnetic field '*B*' due to a long straight conductor carrying current *I* using Ampere circuital law. **[2]**

(iv) Write the truth table for the combination of the gates shown in the figure. **[2]**



(v) Complete the following nuclear reactions. **[2]**

1. ${}_{13}A^{27} + {}_{0}n^{1} \rightarrow {}_{11}Na^{24} + ...$

2. ${}_{1}H^{1} + {}_{1}H^{1} \rightarrow {}_{1}H^{2} + ...$

(vi) 1. Write down the relationship between relative permeability and magnetic susceptibility. **[1]**

2. The decay constant of the radioactive element radium is 4.28×10^{-4} year^{-1}. What will be its half-life? **[1]**

(vii) Write any ***two*** conclusions drawn from Rutherford scattering experiment. **[2]**

(viii) 1. In Young's double slit experiment, the separation between the slits is halved. What happens to the fringe width? **[1]**

2. Write down the relationship between angle of polarization and refractive index of the medium. **[1]**

PART II

SECTION A (28 marks)

Answer any **four** *questions.*

Question 2.

(a) Name the factors on which capacitance of a parallel plate capacitor depends. Give the corresponding relation. **[2]**

(b) An α-particle is accelerated to a potential 10^6 volt from the position of rest. Calculate its energy in electron volt. **[2]**

(c) Write any ***three*** differences between Joule's heating effect and Peltiers' effect. **[3]**

Question 3.

(a) State Kirchoff's laws for electrical circuit. **[2]**

(b) A power line of resistance 0.4Ω carries a constant current of 90A. How much energy is lost per day in the form of heat in the line? **[2]**

(c) Distinguish between paramagnetic and diamagnetic substances. **[3]**

Question 4.

(a) Obtain an expression for potential energy of a system of three charges. **[3]**

(b) An electric charge is uniformly distributed on the surface of a hollow sphere. State how the values of electric intensity E and potential V vary: **[2]**

(i) inside the sphere and

(ii) outside the sphere.

(c) Mention any ***two*** special properties of an LCR circuit at resonance. **[2]**

Question 5.

(a) What is the nature of a magnetic field in a moving coil galvanometer? State its importance and briefly explain how it can be achieved. **[3]**

(b) Give ***two*** advantages of a moving coil galvanometer over a tangent galvanometer. **[2]**

(c) An induced current has no direction of its own. Explain. **[2]**

Question 6.

(a) What is magnetic Lorentz force?

(b) The magnetic induction (B) and magnetizing field (H) in a sample of magnetic material are 1.2T and 2000 Am^{-1} respectively. Find the: **[3]**

(i) magnetic permeability (μ),

(ii) relative magnetic permeability (μ_r) and

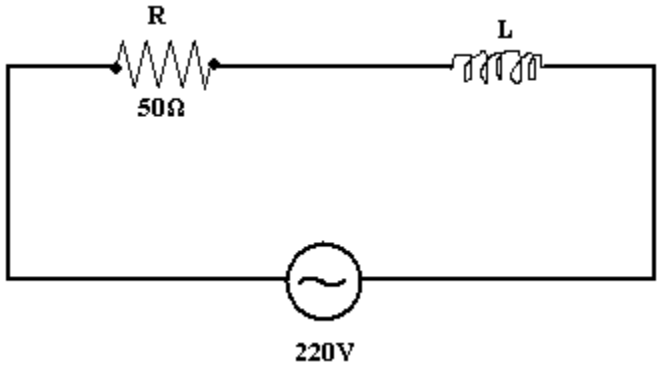
(iii) magnetic susceptibility (χ_m).

(c) Derive the expression for force per unit length between two long parallel current carrying wires. **[3]**

Question 7.

(a) Explain with the help of a circuit diagram, how potentiometer is used to compare the emfs of the cells. **[3]**

(b) In the circuit diagram given below, the current is found to lag behind the voltage by an angle 60°.



Calculate the: **[3]**

(i) inductive reactance,

(ii) impedance of the circuit and

(iii) current flowing in the circuit.

(c) Write down the definition of an ampere based on the force between two current carrying wires. **[1]**

SECTION B (18 marks)

Answer any **three** *questions.*

Question 8.

(a) Define luminous intensity. State its S.I unit. **[2]**

(b) Explain the formation of rainbow with the help of a sketch diagram. **[2]**

(c) Obtain an expression for the diffraction of the first minima in the diffraction pattern. **[2]**

Question 9.

(a) State the necessary conditions for sustained interference pattern. **[3]**

(b) A ray of light passes through an equilateral glass prism such that the angle of incidence is equal to the angle of emergence. If the angle of emergence is $\frac{4}{5}$ times the angle of the prism, calculate the refractive index of the glass prism. **[3]**

Question 10.

(a) A blue light of wavelength $4000\,\overset{0}{\text{A}}$ from a narrow slit is incident on a double slit. The distance of the 10^{th} fringe from the centre is 2 cm and a screen is placed 200 cm away from the slits. Find the slit separation. **[2]**

(b) Can a converging lens in one medium behave as a diverging lens in some other medium? Support your answer. **[2]**

(c) Why is a reflecting telescope preferred in astronomy? **[2]**

Question 11.

(a) Diffraction is common in sound but not common in light waves. Why? **[3]**

(b) Derive the expression for the magnifying power of a simple microscope in normal adjustment. **[3]**

SECTION C (14 marks)

Answer any **two** *questions.*

Question 12.

(a) With the help of a diagram, describe G.P Thomson's experiment to prove wave nature of electrons. **[3]**

(b) An X-ray tube is operated at 18 kV. Calculate the maximum velocity of the striking electrons and the minimum wavelength of the X-ray produced. **[3]**

(c) Define threshold frequency. **[1]**

Question 13.

(a) How is the intensity of X-rays increased in an X-ray tube? **[1]**

(b) (i) What is the depletion layer in a p-n junction diode? **[1]**

(ii) Draw a labelled circuit diagram of a transistor oscillator. **[2]**

(iii) Why does a p-n junction diode offer low resistance in forward bias and a high resistance in reverse bias? **[2]**

(iv) Is it possible to measure the potential barrier of a p-n junction by using a sensitive voltmeter across its terminal? Support your answer. **[1]**

Question 14.

(a) Distinguish between the following pairs. **[3]**

(i) pair production and nuclear annihilation,

(ii) nuclear fusion and nuclear fission reactions

(iii) free neutron and bound neutron.

(b) Deduce the relation $N = N_0 e^{-\lambda t}$. **[3]**

(c) What is meant by binding energy of the nucleus? **[1]**

[PHYSICAL CONSTANTS]

Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ Fm^{-1}
Planck's constant	$h = 6.63 \times 10^{-34}$J.s
Electron charge	$e = 1.6 \times 10^{-19}$ C
1 electron volt	1eV = 1.6×10^{-19} J
Speed of electromagnetic wave	c = 3×10^{8} ms^{-1}
Energy equivalent of	1u = 931 MeV
Mass of an electron	$M_e = 9.1 \times 10^{-31}$ kg
Absolute magnetic permeability	$\mu_0 = 4\pi \times 10^{-7}$ SI unit